Small Business Innovation Research/Small Business Tech Transfer

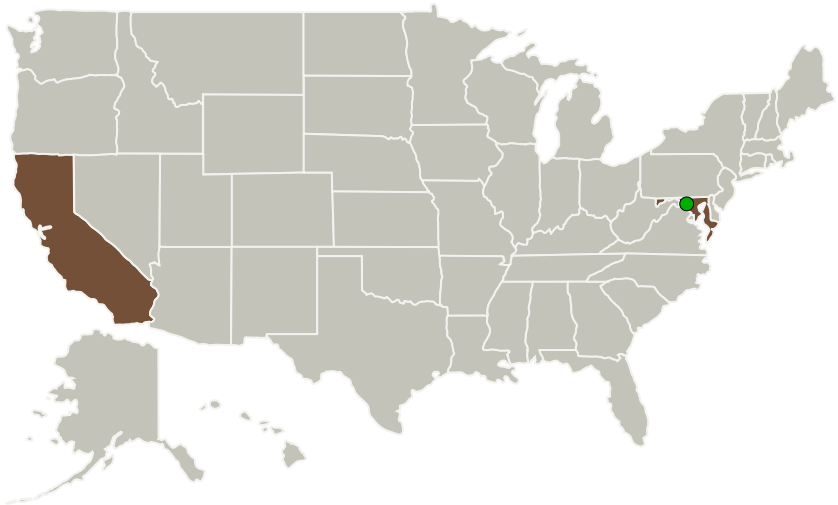
High Energy Single Frequency Yb:YAG Crystalline Fiber Waveguide Master Oscillator Power Amplifier, Phase I

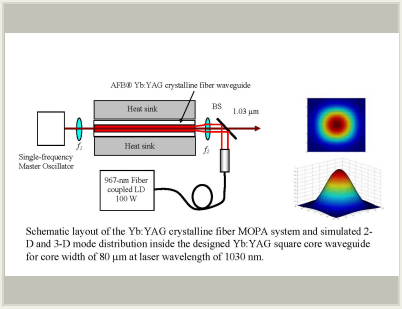
Completed Technology Project (2013 - 2013)

Project Introduction

The overall objective is to demonstrate the concept of Yb:YAG crystalline fiber MOPA laser and investigation the technical feasibility toward 50 mJ single frequency MOPA system in the Phase-II research. Onyx Optics crystalline fiber waveguides are made from true rare-earth doped YAG crystals with Adhesive-Free Bond (AFB®) technology. Compared with silica or phosphate glasses, the YAG crystalline fiber waveguides have the following advantages: (i) YAG crystal has at least one order of magnitude lower Stimulated Brillouin scattering (SBS) gain coefficient than silica or phosphate glasses (10-15 to 10-12 vs 10-11 m/W), which directly leads to the SBS free power being at least one order of magnitude higher than the glass fibers; (ii) YAG crystal has much higher thermal conductivity than glass fibers (10.7 vs 1.38 W/m degree C). Therefore, much shorter fiber length that is only about one tenth of the glass fiber can be used for the same pumping conditions and the SBS threshold can be further increased; (iii) Due to the shortening in the fiber length, straight fiber can be practically used for high power amplification. Therefore, large single mode area (LSMA) can be more easily achieved. Considering the high pulse energy requirement in a future LIST mission, only large mode area (LMA) Yb:YAG fibers with core size >40 mm will be fabricated and investigated in the Phase-I research. The fibers will be double clad to increase the pumping power and efficiency, while maintaining near diffraction limit laser beam quality.

Primary U.S. Work Locations and Key Partners





Schematic layout of the Yb:YAG crystalline fiber MOPA system and simulated 2-D and 3-D mode distribution inside the designed Yb:YAG square core waveguide for core width of 80 μm at laser wavelength of 1030 nm.

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Organizations Performing Work	Role	Type	Location
Onyx Optics, Inc.	Lead Organization	Industry	Dublin, California
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
California	Maryland

Project Transitions

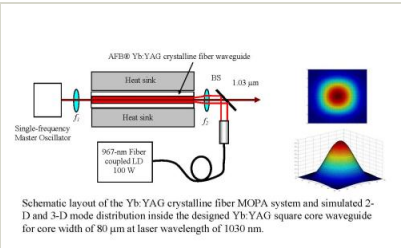
May 2013: Project Start

November 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138200)*

Images



Schematic layout of the Yb:YAG crystalline fiber MOPA system and simulated 2-D and 3-D mode distribution inside the designed Yb:YAG square core waveguide for core width of 80 μm at laser wavelength of 1030 nm.

Project Image
High energy single frequency Yb:YAG crystalline fiber waveguide master oscillator power amplifier *(https://techport.nasa.gov/image/131100)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Onyx Optics, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

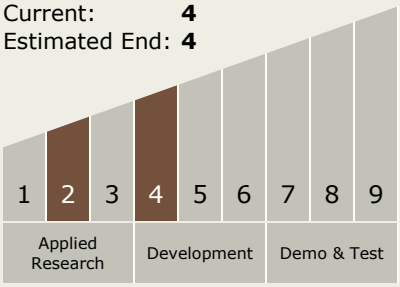
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Xiaodong Mu

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.5 Lasers

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System